Report for 2001CO822B: Enhancements to the South Platte Mapping and Analysis Program (SPMAP)

- Conference Proceedings:
  - Garcia, Luis; 2001, South Platte Mapping and Analysis Project, in Wassup in the South Platte Basin, Proceedings of the 12th Annual South Platte Forum, October 24-25, 2001, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO, p. 33.
- Other Publications:
  - Garcia, Luis, 2001, Enhancements to the South Platte Mapping and Analysis Program (SPMAP), Progress Report presented at the CWRRI Advisory Council on Water Research Policy (ACWRP) annual meeting, November 5, 2001, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO.
- unclassified:
  - Garcia, L.A. South Platte Mapping and Analysis Program, presented at the 21st Annual Hydrology Days, April 2-5, 2001, Ft. Collins, CO Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO.
  - Garcia, L.A., 2001, South Platte Mapping and Analysis Program, presented at the 2001 GIS of the Rockies Conference, September 20th, Denver, CO.

Report Follows:

SYNOPSIS

Project Number: 2001CO822B   Start: 3/01
                                                                  End: 2/02

Title: Enhancements of the South Platte Mapping and Analysis Program (SPMAP)

Investigators: Luis Garcia, Colorado State University, Fort Collins, CO

Congressional District: 4th

Focus Categories: AG, GW, WU

Descriptors: Conjunctive use, Groundwater-surface water, Augmentation,
                        Geographic information system, Agricultural consumptive use

The Issue

Water managers in Colorado are faced with balancing many competing demands for water.
Water is needed for crop irrigation, for domestic use, for mimicking natural flow rhythms to
protect aquatic habitat, and for recreation. In order to meet the challenge of allocating a finite
amount of water amongst an increasing number of users, water managers need sophisticated
tools. The South Platte Mapping and Analysis Program (SPMAP) provides water managers with
a common set of computer tools and data that can be used to accurately estimate augmentation
requirements and model the area for future changes.

History of the Project

In the 1970s and 1980s, CWRRI funded research to develop mathematical models describing
interactions between surface and groundwater in alluvium aquifers along the South Platte River.
The utility of these early models was limited by the available technology. At that time, it was
difficult to integrate data systems into the models, and user interfaces were daunting rather than
friendly. In the ensuing years, microcomputers and satellite technology have improved
dramatically allowing for the creation of SPMAP.

The SPMAP project began in 1995 when the IDS Group, directed by Dr. Luis Garcia at Colorado
State University, started to work with a number of local and regional water management
organizations along the South Platte River. As a consequence of the combined support of the
CWRRI at CSU and the water management organizations SPMAP has become a benchmark of
applied research resulting from collaboration and communication with end users.

SPMAP is a set of computer tools constructed to enhance water management by carefully
matching data acquisition system design, modeling, and user interfaces to meet the needs of
decision makers in the Lower South Platte River Basin. SPMAP is a data centered, modular set
of tools. This means that the data are generic and tools are developed in such a way that all the
modeling efforts can use the same data. Individual models are developed as part of a larger

framework but can be easily added or subtracted from the system in response to the needs of the user.

Water managers and the IDS Group initially identified two pressing needs for the South Platte River Basin. The area needed an accurate spatial database and a set of analytical tools for computing farm water budgets and consumptive use (CU) of groundwater in order to help quantify the impact of groundwater well pumping on the flows of the South Platte River.

During 1995-96, project efforts focused on spatial data collection and evaluation. A Geographic Information System (GIS) module was developed as an extension to ArcView 3.0a. The GIS module allows the user to view point, line, polygon, and image coverages. The current system contains themes for irrigated lands, well locations, stream depletion factors, hydrography, weather stations, county boundaries, roads, cities, and more.

In 1997-1998, the project focused on developing a Consumptive Use (CU) Model and an interface for a Stream Depletion Factor (SDF) Model. Satellite images were purchased to determine irrigated land area. A Graphical User Interface (GUI) for the CU Model was constructed. The GIS module can be used to locate fields and the surface and/or groundwater sources that provide water to them. This information along with the crop types grown in each field and the weather station information can be stored in an ASCII file. The CU Model imports the ASCII file and uses it to create an input file that is used to calculate the CU and any pumping requirements.

During 1998-1999, SDFView and the Stream Depletion Factor (SDF) Model were released. SDFView can be used to estimate the lag time when irrigation well water is pumped from or water is recharged to an alluvial unconfined river aquifer and when a depletion or accretion happens in the river. Required input information for SDFView is irrigated consumptive use from well water or net recharge amounts and SDF values for irrigation wells or recharge basins. SDFView is a stand-alone interface for Windows 95/98/NT. SDF View was released as part of the Three State Agreement to the State of Nebraska to help them manage South Platte groundwater wells in Nebraska.

In 1999-2000 the project team concentrated on finishing SPMAP, SDFView and CU Model interfaces to the satisfaction of the cooperating water managers and the IDS Group. A stand-alone interface for the CU Model was developed. This interface makes the CU Model more flexible although coordination with SPMAP still makes data entry easier and more comprehensive.

Additional options were added to the CU Model in 2000-2001. Water managers requested that CU Model be able to retrieve data from HYDROBASE, a statewide model being developed by the state engineers office. A new version of the CU Model was introduced with this added capability.

Accomplishments for 2001-2002

Participating organizations recommended that the IDS Group should continue to enhance the SPMAP tools in 2001-2002. In response, the IDS Group upgraded the GIS data layers and added functionality to the SPGIS. All the GIS data layers were re-evaluated and a metadata file was created for each of them. The following coverages were upgraded or created this year:

- Roads
- Wells
- Cities
- Stream Depletion Factors (10-day)

The extension that has been created to allow users to export GIS information into the CU model can now be downloaded along with most of the GIS data layers from a webpage. The URL for the website is:

> http://www.ids.colostate.edu/projects/spgis/index.html.

In a significant change to the SPGIS system, the process of creating input to the SPCU model has been streamlined. The SPCU model editor has now been linked to an icon in ArcView. To bring up the editor, the user clicks on the icon of the well shown next to the scissors in the Figure 1.
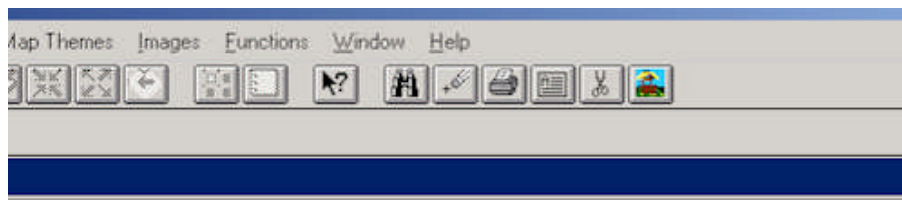

Figure 1: Well Icon in ArcView

A pop-up window is displayed (Figure 2).

This window contains tools for creating and editing the layers required by SPCU. This includes functions for creating new irrigated fields and assigning attributes to them such as crop type and field application efficiency. Fields are then assigned to farms, which can then be exported to serve as the basis for a new SPCU input dataset. This dialog has been significantly enhanced based on input from the water users.

Another function that has been added to SPGIS is the ability for the user to create a well theme from HYDROBASE based on the legal description. Also, the capability of SPGIS to generate well locations from legal descriptions has been improved by changing the procedure used to locate points in alliquate sections; the error in irregular sections is now moved to the northwest corner. The pop-up screen for allowing the user to generate legal description locations for points is shown in Figure 3.

Figure 2: SPCU Input Editor

Figure 3: Generating Well Locations from Legal Descriptions

Output displays for the CU Model were expanded to include all year types (calendar, irrigation, and water).

To better analyze wells and recharge occurring close to the river, SDFDaily was created so that stream depletions and accretions could be computed and displayed on a daily basis. SDFDaily is based upon the Analytical Stream Depletion Model, a model created by the Office of the State Engineer-Division of Water Resources.

The Analytical Stream Depletion Model allows the user to assess the impacts of an alluvial groundwater well or a groundwater recharge facility on a nearby stream. The output of hydrographic data is displayed in user-specified time-steps and using different boundary conditions, important considerations when analyzing wells or recharge facilities within a mile of the stream channel. Depletion can be computed to a stream of infinite length or to a segment of the stream. Pumping can be input at a constant or variable rate. No-flow boundaries can be simulated parallel or perpendicular to the stream. Stream depletion factor is computed using equations described by Glover and others. The source code for the program is written in BASIC.

SDFDaily translates the Analytical Stream Depletion Model into the C^{++} programming language, adds graphic capabilities to the model, and gives the model a new, user-friendly interface. Users still specify yearly, monthly, weekly, or daily time-steps, but now with SDFDaily output data is displayed in graphs and tables. Figure 4 shows the input screen.

Figure 4: Input Screen for SDFDaily

Figure 5 shows SDFDaily output.

SDFDaily can also be operated in a modified mode (Figure 6), which is based upon the SDFView interface. It is anticipated that SDFDaily will eventually replace SDFView.
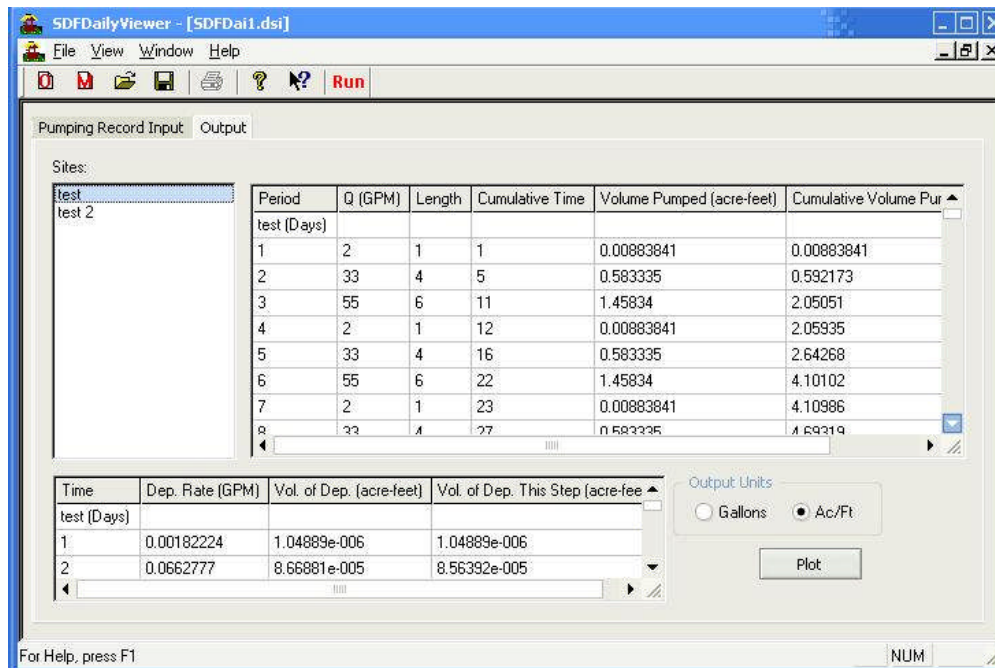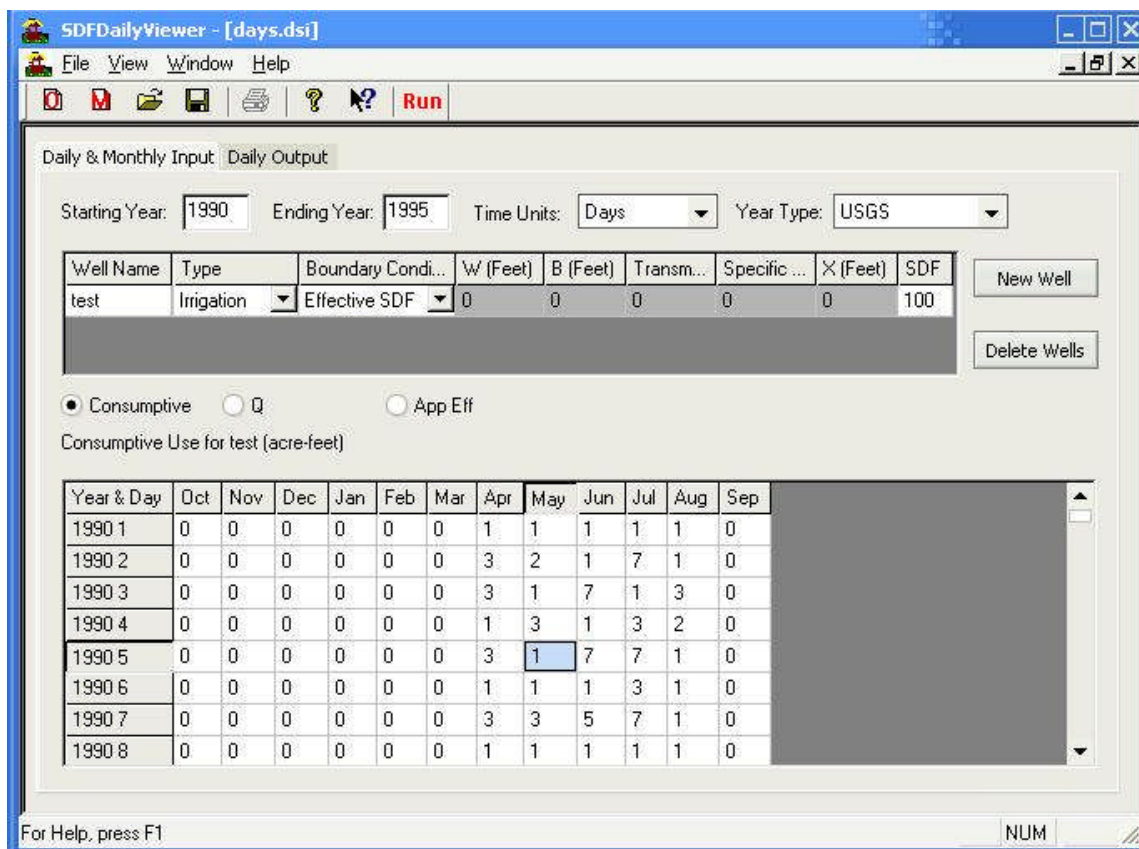
Figure 5: SDFDaily Output Screen

Figure 6: SDF Daily Input Screen with an Interface Based on SDFView

The SDFView model is used by a number of water users groups. It is used regularly by the Ground Water Appropriators of the South Platte and the Northern Colorado Water Conservancy District.

This year Central Colorado Water Conservancy District started to digitize all their fields and farms and the locations of their wells. They are planning to use all the tools developed as part of this process to help them develop their augmentation requirements. We worked closely with them in making enhancements tools to simplify the process. This process was very rewarding and productive for us. Next year they plan to expand their use of the tools and provide additional matching funds for development of additional capabilities to the system to allow them to import all their historical data and to create some additional capabilities for them.

Module upgrades can be accessed through the IDS website.

> http://www.ids.colostate.edu/projects/splatte

The IDS Group at CSU continued to work closely with local water organizations. Ongoing efforts include developing a model to assist in assessing wildlife habitat in the South Platte, upgrading interfaces, and developing tools for accessing databases of the water user groups.

Team Participants

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> Jon Altenhofen, Northern Colorado Water Conservancy District
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> Forrest Leaf, Central Colorado Water Conservancy District
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